

# The Radulae of *Tegula* Species from the West Coast of North America and Suggested Intrageneric Relationships

BY

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(10 Text figures)

THE RADULAE of ten species of *Tegula* from the Pacific Coast of the United States and Mexico have been examined in an effort to determine intra-generic relationships. These specimens were kindly arranged for or provided by Dr. Rudolf Stohler. They were collected from Central and Southern California and from Northern Baja California, Mexico, the localities and numbers of specimens that were studied from each area being shown in Table 1.

Table 1

<i>Tegula aureotincta</i> (FORBES, 1852) Point Loma, San Diego County	6
<i>Tegula brunnea</i> (PHILIPPI, 1848) Horseshoe Cove, Sonoma County	6
<i>Tegula eiseni</i> JORDAN, 1936 San Diego, San Diego County	6
<i>Tegula funebris</i> (A. ADAMS, 1854) Bodega Head, Sonoma County	6
<i>Tegula gallina</i> (FORBES, 1850) La Jolla, San Diego County	3
<i>Tegula mariana</i> (DALL, 1919) 6 mi. S. of Puertocitos, Baja California, Mexico	5
<i>Tegula montereyi</i> (KIENER, 1850) Carmel, Monterey County	3
<i>Tegula pulligo</i> (GMELIN, 1790) Horseshoe Cove, Sonoma County	6
<i>Tegula regina</i> (STEARNS, 1892) Catalina Island, California	5
<i>Tegula rugosa</i> (A. ADAMS, 1853) San Felipe, Baja California, Mexico	6

## MATERIALS AND METHODS

The radulae were prepared by the procedure described by FRITCHMAN, 1960. The snail is removed, the shell

being cracked if necessary, and the body dissolved in 10% NaOH. The radula is stained in acetocarmine and mounted in Euparal. The radula is not easily arranged since it is broad and the margins tend to curl under and resist being flattened. This restricts detailed study to the central region. Because the ends of the ribbon are either worn or in the process of being formed, only the central half, in a longitudinal sense, was examined.

## RESULTS

The radula of *Tegula funebris* is described and figured by THIELE in TROSCHEL, 1866 - 1893 (vol. 2, p. 234; pl. 23, fig. 15) as *Omphalius (Chlorostoma) funebris* ADAMS. This description fits, in a general way, all of the ten species examined. There is a single, unornamented central tooth flanked by five lateral teeth with heavy blades which bear two to four minor teeth in the region between the blade and the stem. Of these the fifth lateral is seen from the side and resembles a bird's beak. Following the laterals is a long series of marginal teeth, up to 146 being counted in *T. eiseni*, many of which cannot be studied because of the curled under edge of the ribbon. These teeth have serrated edges and do not possess the large triangular blades of the laterals. The serration may be present and obvious on number one tooth, the most medial, or may not become evident until farther along in the row. The first teeth may not be completely serrated, the serration progressing toward the tip on subsequent teeth. Finally, the medial marginals may have pointed tips which become rounded or squarish in teeth more lateral in the row. These features are summarized in Table 2. The length/width ratio of the central tooth was determined by measuring ten teeth from the central portion of each of three radulae. A representative section from a radula of each species is shown in the accompanying text figures.

DISCUSSION

The intra-generic and intra-specific stability of the *Tegula* radula, in-so-far as examined, is great and this, to an extent, compensates for the small number of specimens studied. The following intra-generic relationships are suggested.

*Tegula gallina* (Figure 1) stands by itself relative to the length/width ratio of the central tooth. The low value

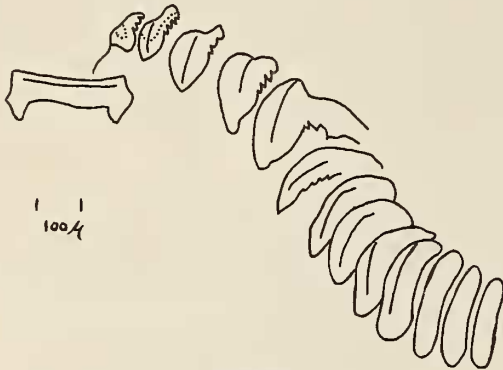


Figure 1:

Radula of *Tegula gallina* (FORBES, 1850)

of 46 % immediately identifies this radula among the other nine. The blades on the lateral teeth are sharply pointed and proportionately more massive than those of the other species. Number one marginal is serrated from the base to the middle but this fades away to reappear on tooth six or seven. Although the length/width ratio of *T. funebris* (Figure 2) is much greater and its lateral

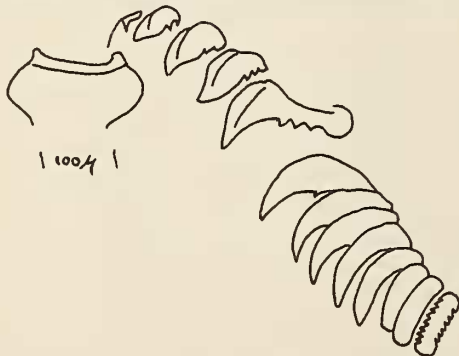


Figure 2:

Radula of *Tegula funebris* (A. ADAMS, 1854)

tooth blades are somewhat less massive, in overall configuration these two radulae seem to be similar and the species possibly related.

*Tegula eiseni* and *T. mariana* (Figures 3, 4) are apparently closely related based upon the proportions of the

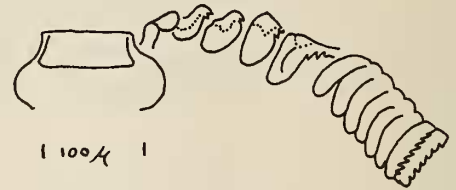


Figure 3:

Radula of *Tegula mariana* (DALL, 1919)

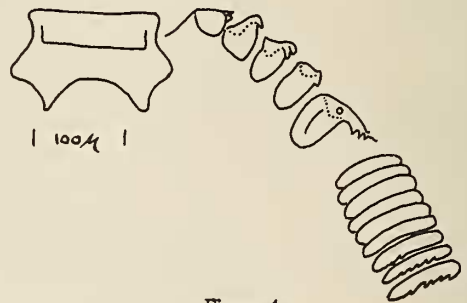


Figure 4:

Radula of *Tegula eiseni* JORDAN, 1936

central teeth, the obtuse tips of the laterals and rounded ends of the marginals. *Tegula regina* (Figure 5) shares these features but differs slightly since it bears serrations



Figure 5:

Radula of *Tegula rugosa* (A. ADAMS, 1853)

on the first marginal. *Tegula rugosa* (Figure 6) differs from the other three species in possessing pointed medial marginal teeth, although the more lateral marginals are rounded.

*Tegula aureotincta*, *T. brunnea*, *T. pulligo* and *T. monteyi* (Figures 7 - 10) all have proportionately smaller, pointed lateral teeth. The serrations on the marginals begin in midblade of number one and progress uniformly to the tips of subsequent teeth in the row. The first few

particularly so in the central tooth proportions and the marginal serrations.

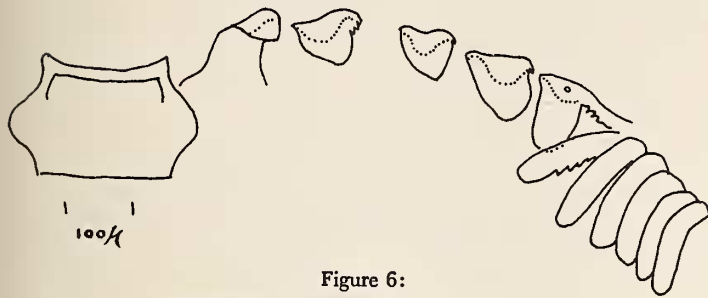


Figure 6:

Radula of *Tegula regina* (STEARNS, 1892)



Figure 9:

Radula of *Tegula pulligo* (GMELIN, 1790)



Figure 7:

Radula of *Tegula aureotincta* (FORBES, 1852)



Figure 10:

Radula of *Tegula montereyi* (KIENER, 1850)

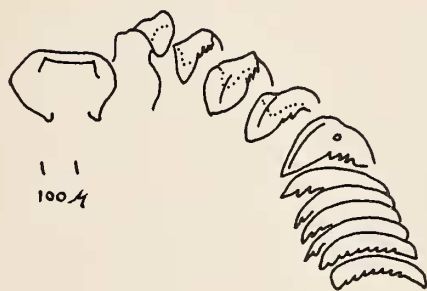


Figure 8:

Radula of *Tegula brunnea* (PHILIPPI, 1848)

marginals always have pointed tips, a feature that tends to separate these species from those of group two. Of these four species, *T. montereyi* appears to be the most variable,

## CONCLUSIONS AND SUMMARY

The radulae of ten species of *Tegula* from California and Baja California have been examined for intra-generic relationships. Three groups of species are suggested as follows:

Group one containing *Tegula gallina* and *T. funebris*.

Group two containing *Tegula mariana* and *T. eiseni*, evidently closely related, and *T. rugosa* and *T. regina* less so.

Group three containing *Tegula aureotincta*, *T. brunnea*, *T. pulligo* and *T. montereyi*.

## LITERATURE CITED

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1960. Preparation of radulae. *The Veliger* 3 (2): 52-53 (1 October 1960)

THIELE, JOHANNES

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1866-1893. *Das Gebiss der Schnecken zur Begründung einer natürlichen Classification*. Vol. 2: viii + 409 pp.; pls. 1-32. Berlin, Nicolaische Verlags-Buchhandlung.

Table 2

Radular character	<i>Tegula gallina</i>	<i>Tegula funebris</i>	<i>Tegula eiseni</i>	<i>Tegula mariana</i>	<i>Tegula regina</i>	<i>Tegula rugosa</i>	<i>Tegula aureotincta</i>	<i>Tegula brunnea</i>	<i>Tegula pulligo</i>	<i>Tegula montereyi</i>
Central tooth length % width range	45.6 (42-52) 10	54.3 (47-63.5) 16.5	55.5 (50-58) 8	55.5 (55-56) 1	64.5 (63-66) 3	59 (55-64) 9	69.5 (66.6-73.4) 6.8	58.5 (56.5-61) 4.5	64 (54-73) 19	60 (55-77) 22
Lateral teeth	pointed massive	pointed	obtuse	obtuse	obtuse	obtuse	pointed	pointed	pointed	pointed
Marginal teeth point of conversion of tip from pointed to round	6-8	5-7	all round	all round	all round	4-7	5-7	3-6	1-4	5-7
Marginal teeth serrations begin	1 fade until 6-9	middle of 1 fade until 6	base of 3-4 fade until 8-9	base of 5	base of 1 fade until 14-18	base of 11-12	middle of 1	middle of 1	middle of 1 or below	variable usually base of 1
Marginal teeth serrations complete	10-11	8-10	12-13	8-10	21-25	13-14	7-8	8-10	7-8	15

## Observations on the Growth of *Cypraea spadicea*

BY

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A RECENT NOTE in the literature by BENTON (1964) prompted a report at this time on some observations which have been made on the local cowrie found along the shores of Los Angeles County.

Several juvenile specimens were collected at low tide on May 16, 1964. In the area at that time were over 200 adult animals as well, hidden in cavities in the rock above the water line and covered with eel grass. During this same period, underwater observations (Dr. R. C. Fay, personal communication) indicated large numbers of the juveniles in deeper water. A specimen was placed in a newly established four-gallon all-glass tank, outfitted with efficient aeration and under-the-sand filtration, and several

rock formations were placed in the tank to provide refuge. Other inhabitants in the tank consisted of two adult *Cypraea spadicea* SWAINSON, 1823 (33 mm and 55 mm in length and collected along with the juveniles), three cling-fish, *Sicyogaster meandrica*, a sea horse (identification unknown, approximately 90 mm from the base of the tail to the top of the head), eight to ten *Conus californicus* HINDS, 1844 (20 mm long), numerous small limpets and other forms brought in on the rocks.

The subject when first caught was 30 mm in length with no trace of adult coloration, but had the usual banded shell and spire. Its mantle was a smoky orange-brown with black polka-dots. Although the young *Cypraea spa-*